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Determinants of Multifactor Productivity: The Cases of the Main Latin American and Successful Asian Economies (1960-2015)

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Abstract

The objective of this paper was to explain the greater or lesser growth rate of total factor productivity, TFP, in the main East Asian and Latin American economies between 1960 and 2015. We found econometric evidence favorable to this hypothesis: the increase in public consumption expenditures, given the evolution of other factors, reduces the TFP. Other results of the econometric exercise, those that are related to hypothetical positive effects of public investment and imports on TFP were not as robust or as reliable as we would have expected.

Keywords

Per Capita GDP's Growth Rate, Total Factor Productivity, Physical Capital, Human Capital, Public Consumption, Public Investment, Imports, Panel Cointegration

1. Introduction

Between 1950 and 2015, GDP *per capita* in Latin America (set of 7 economies of the region) went from 2662.5 to 8515.1 in 1990 international dollars[1]; the GDP *per capita* of "Asia" (set of 9 successful economies of Asia)[2] went from 565.6 to

[1]i.e. measured in the so-called "1990 International Geary-Khamis dollars." Data for the years 2009-2015 were obtained by connecting the Maddison Database 2010 series (with information up to 2008) with the growth rates of GDP *per capita* (rgdpnapc) and the population of Maddison Project Database 2018.

[2]What we call "Latin America" in this document comprises Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela. "Asia" includes China (mainland), Hong Kong, India, Indonesia, Malaysia, Singapore, South Korea, Taiwan and Thailand. An important precision is needed about Hong Kong and Taiwan: although Hong Kong is officially a China's special administrative region and the political status of Taiwan is still uncertain (although reclaimed by China), in the economic literature and in some international databases (PWT, TED and Maddison Database for example) they are often considered as independent or autonomous economies. In this work, we follow such consideration.

8018.6, also measured in 1990 international dollars. Thereby, whereas in 1950 the GDP *per capita* in Asia was only 21.2% of Latin American GDP; in 2015, both of them were almost equal (around 94.2%).

The eradication of the *per capita* income gap between these two regions derived from the extraordinary dynamism of Asia and the weakening of the economic growth of Latin América; mainly, since the beginning of the 1980s. In fact, whereas between 1950 and 1980 the GDP growth *per capita* was similar (2.7% annual average) in both regions, during the three and a half following decades, the economic growth of Latin America and Asia was 1.1% and 5.4% annual average, respectively. From 1950 to 2015, the average annual GDP growth rate *per capita* was 1.8% in Latin America and 4.2% in Asia.

This aggregate behavior of both regions hides, in one of the cases, important differences in their national economies' performances; at least, when it is considered the small economies group *versus* the large economies group. In the case of Latin America, except for Chile, the reduction of the growth rates between these two long periods (1950-2015) of time was widespread, although this fall was much higher in the largest economies (the GDP annual growth rate *per capita* decreased from 3.6% to 1%) than in the small economies (from 1.6% to 1.2% per annum).[3]

In contrast, in the case of Asian economies, the growth dynamics between these two groups (large and small economies) was quite different[4]: the *per capita* income of the small economies group grew faster than the one of the big economies group from 1950 to 1980 (4% and 2.3% per annum, respectively), whereas between 1980 and 2015, this behavior turned upside down (4% and 5% per annum, in the given order). Throughout the six and a half decades analyzed, the *per capita* income growth of both economies groups is almost the same (4% in the small economies group and 4.2% in the big economies group).

This brief description about long-term performances in Latin America and Asia allows us to affirm that their most outstanding aspects were, on one side, the low dynamism of the first region and the extraordinary growth of the second one; and, on the other side, the weakening (in one of the cases) and the acceleration of growth (in the other case) registered in the two regions in the last 35 years in relation with the three previous decades.

What is behind those important differences in economic growth of these two

[3]The economies that have consolidated as the largest in Latin America in terms of both population and GDP are Brazil and Mexico. In fact, their share in the GDP of the seven economies under consideration increased from 45.5% in 1950, reaching a peak of 65.5% in 1989; it then declined slightly to 60.4% in 2015. Argentina's economy, which for most of the 1950s was as large as those of Mexico and Brazil because of its relative importance in regional GDP, has recorded a significant decline since then, as has its population, although to a lesser extent. A similar behavior is observed in Venezuela in terms of the importance of its economic activity.

[4]The large economies of Asia are China and India, although the relative importance of the latter in the GDP of the nine economies considered has declined sharply. Due to this behavior of India, the joint participation of these two countries has increased from approximately 80% in the 1950s to just under 70% in the 1990s, and has again reached 80% in recent years. The other economies are very far apart in terms of both population and GDP.

regions?

With this article, we seek to partly answer this question. With respect to this, in Section 2, we present our hypothesis and we reference the publications where such hypotheses come from. In Section 3, we explain the strategy we developed in the econometric work and its results. In Section 4, we summarize the work and we present our conclusions. As annex, we reported our measurements of variables and statistical sources used; there, we describe (and justify) the empirical work we did to build some of the variables used in the econometric exercises we employed to prove our hypothesis; and we present the results of diverse econometric tests.

2. Literature and Hypothesis

The literature has pointed that in *per capita* income differences among countries and their long-term economic growth rates are mainly explained because of the levels and the dynamic of multifactor productivity of economy or, in other words, the efficiency of countries to use their production factors available.

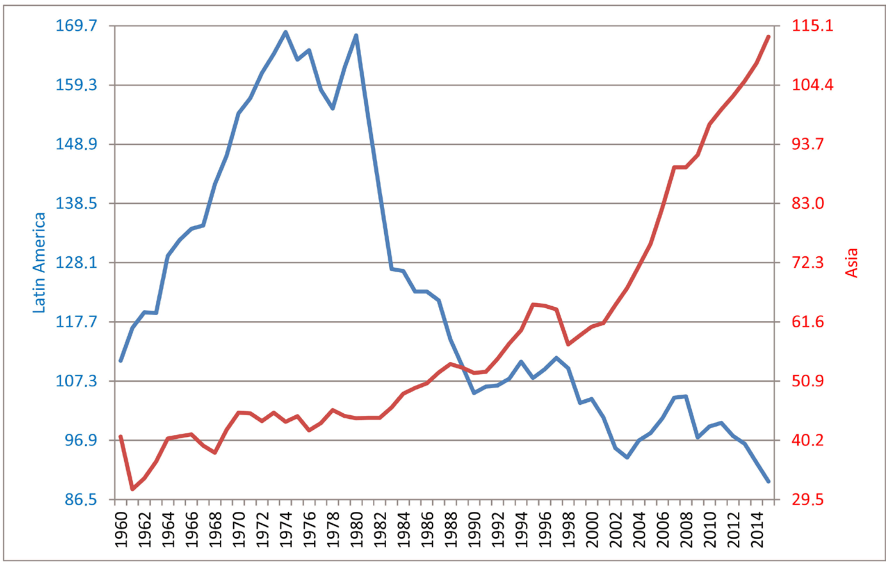
Thus, after taking into account the accumulation of both human and physical capital, there is "something else" that represents the biggest part of the differences between *per capita* income levels and economic growth rates among countries. Consequently, the core problem facing analysts in understanding economic development and economic growth is not understanding the process through which an economy makes increase both its saving and physical capital accumulation rates, but understanding "something else" plays an outstanding role for explaining differences in long-term economic performance among countries (Easterly & Levine, 2001).[5] Generally, economists use the term "total factor productivity", *TFP* to refer to that "something else".

In spite there is/In spite of relative consensus among academics on the importance and *TFP* measurements (or "aggregate productivity" or "multifactor productivity"), no consensus exists on its determinants. Actually, the diverse models of endogenous growth are based on this hypothesis about different *TFP* growth engines. This evinces very different conceptions of *TPF*.

Fernández-Arias (2017) points that *per capita* GDP growth gaps and *TFP* of Latin America, in relation with the rest of the world, seem larger and more systematic. Whereas accumulation of factors in Latin America has been aligned with the rest of the world, its economic growth is different because of its lower growth of *TFP*.

Figure 1 represents *TFP* evolution in both regions. As can be seen, in Latin America this variable increased rapidly in the 1960-1980 period (2.1% per annum); subsequently, it was registered a sustained reduction (−1.8% per annum). For its part, this variable increased steadily in Asia, slowly in the first two decades (0.4% per annum), but rapidly from the beginning of the 1980 decade (2.7%

[5]As these authors point out, this does not mean that the accumulation of factors is not important in general or that it is not critical for some countries at specific times.



Source: Penn World Tables (PWT 9.0) except for Argentina, whose source is mentioned in Annex 1. Calculations by authors.

Figure 1. Multifactor productivity (*TFP;* indices in Latin America and Asia 1960-2015 (2011 = 100)).

per annum). It also can be observed that this aggregate productivity behavior went hand to hand with GDP evolution *per capita* in both regions, at least with regard to long term tendencies.[6]

Between 1960 and 1980, the growth of Latin American productivity was boosted by the larger economies of the region (3.3% per annum), whereas the growth of the smaller economies set was low (0.5% per annum). For its part, the fall in productivity for the three and a half following decades (1980-2015) was generalized, but it was larger in the first ones (−2.1% per annum) than in the second ones (−1.1% per annum).[7] It can be said that, in the 1960-2015 period, Latin American productivity was stagnant (−0.4% per annum).[8]

In the Asian case, productivity growth between 1960 and 1980 was driven by

[6]Although GDP *per capita* and multifactor productivity are based on different measures (the former in purchasing power parity or 1990 international dollars and the latter obtained from national accounts figures at constant 2011 prices of the respective economies converted to 2011 dollars), this difference does not create major problems of comparison in terms of their trends and growth rates. In fact, the ratios of Asia's *per capita* GDP to Latin America's, measured in both forms (1990 international dollars and in constant 2011 prices of the economies converted to 2011 dollars), show the same pattern (almost stagnation in the period 1950-1980 and rapid increase thereafter), although the percentage values differ to some extent. These differences can be explained by the prices used and the choice of the base year.

[7]In fact, the peak in productivity for the region in 1980 is explained by Brazil, Colombia, and Mexico, since for the other economies it occurs in 1970 (Venezuela) and 1974 (Argentina and Peru). In these countries, productivity clearly drops afterwards. Although the behavior of productivity in Chile follows a different pattern since the early 1970s, a stagnation is observed between 1980 and 2015. However, between 1985 and 2015, it records an increase amidst fluctuations of medium duration. It also shows that Chile does not escape from the pattern of low productivity performance typical of Latin America.

[8]For larger economies the growth rate was calculated by the authors at -0.2% per annum, and in smaller economies (−0.5% per annum).

small economies (3.4% per annum), whereas productivity acceleration was driven by large economies between 1980 and 2015 (3.1% per annum).[9] This relief explains the important growth of Asian productivity during the five and a half decades under analysis (1.9% per annum).

Economists have pointed to a set of determinant variables of aggregate productivity behavior, among which international trade openness and the importance of public sector in economy can be highlighted (Loayza, Fajnzylber, & Calderón, 2005). Before describing the evolution of these variables in both regions, a clarification deems necessary: as opposed to Latin America, aggregate data from Asia conceal marked heterogeneities among its economies, either as GDP percentages or in *per capita* terms.

Trade openness directly influences total productivity of factors through, at least, two channels: on the one hand, by means of technological innovation diffusion and improvements in managerial practices, since they reinforce the interaction between national enterprises and external enterprises as well as markets; and, on the other hand, by virtue of sparse incentives that local enterprises receive when openness is absolute or almost absolute, in order to perform unproductive rentier activities and anticompetitive practices (Loayza, Fajnzylber, & Calderón, 2005). Particularly, the "new" growth theories have given a persuasive support to the proposition that openness affects growth positively, since they argue, for instance, that countries more open to the rest of the world have a higher capacity to absorb the new technological advances generated in leading nations (Edwards, 1998).

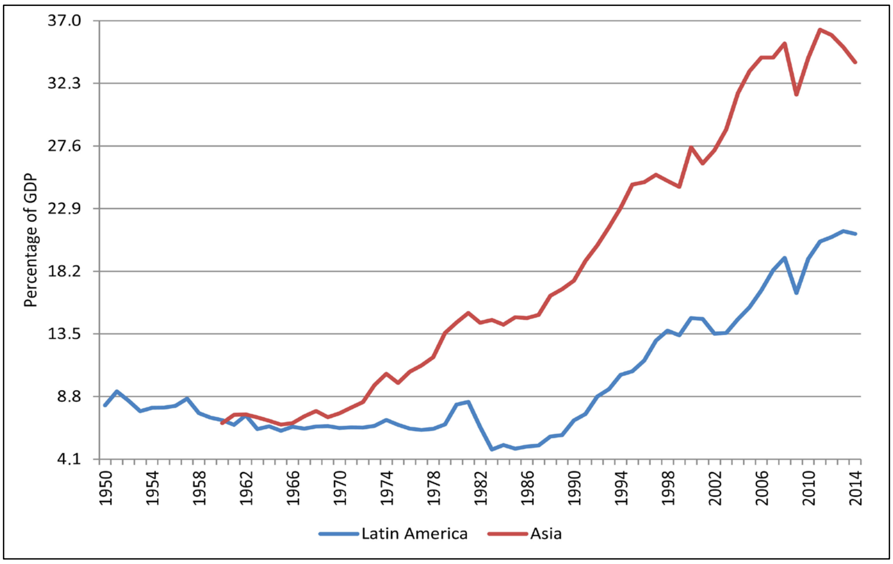
In fact, a great deal of empirical evidence shows a positive relation between economic growth and international openness. This reflects a virtuous circle in which a larger openness drives to a larger growth, which generates more commerce.[10] In a review of empirical evidence on the effects of trade liberalization on business innovation, Shu and Steinwender (2018) have concluded that trade liberalizations, for the case of emerging countries, seem to stimulate productivity and innovation.

Figure 2 shows the evolution of the openness degree of Latin American and Asian economies under consideration, measured by participation of imports in GDP. It can be seen from the figure that from the 1950s to the end of the 1980s, there was an obvious steady downward trend.[11] Since then, it registers an increase practically sustained to reach levels around 21% of GDP in 2014. This greater openness of Latin American economy was associated to the agenda of

[9]In the first period (1960-80), productivity growth in the large economies was −0.6% per year, due to the sharp drop in productivity in China. In the second period (1980-2015), productivity growth in the group of small economies was 1.4% per year.

[10]Besides, international trade allows countries to exploit their comparative advantages and to expand their potential markets; it leads to a greater specialization and allows national companies to make the most of economies of scale, which generates productivity gains (Lederman, 1996, cited by Loayza, Fajnzylber and Calderón, 2005).

[11]A discussion about different openness measures and their relation with economic performance of countries, as can be seen in Pritchett (1996).



Note: Import and GDP figures are in real terms. Data used for China corresponds to "Alternative China". Source: Penn World Table 9.0. Calculations by authors.

Figure 2. Evolution of the degree of openness in Latin America and Asia, 1950-2014.

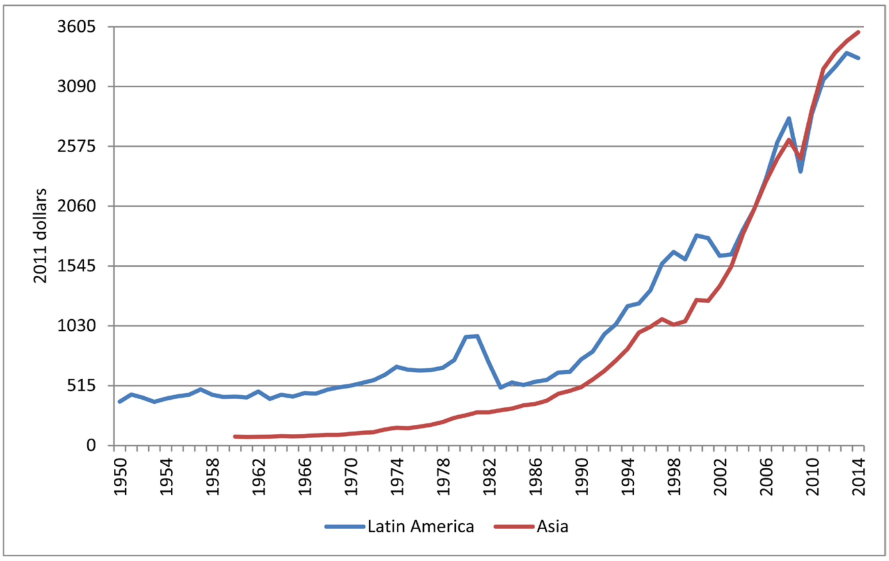
structural reforms onset in the region, mainly since the 90s. Two important components of this agenda were trade liberalization, in other words, a deeper trade integration with world economy, and a reduction of obstacles and disincentives to foreign direct investment (Ros, 2014).

In terms of external openness, the course of economies hereby considered is different. In effect, its opening process started in the beginning of 1970s and, clearly, it has been a region much more open to international trade than Latin America. It can be observed that the openness degree of the regions set was practically similar to the Latin American set in the 60s (around 7% of GDP); since then, it grew up to 35% during the last years. It is worth noting that this aggregate behavior hides heterogeneity between these economies: Hong Kong *and* Singapore are fully open economies, followed by Malaysia; whereas China and India are much less open.

However, despite these significant differences in openness degrees of Asian economies, they all moved in the same direction. In particular, those less open (China and India) than those of Latin America in the 1960s have recently become a little more open than the Latin American group.

On the other hand, the differences in openness degrees between Latin American countries are substantially smaller, this reflecting convergence between institutional structure and economic policy in the region. This can be explained by the fact that in the first decades of the post-war period, industrialization was driven by the State and focused on the domestic market, and subsequently derived from the process of economic liberalization (Ros, 2014).

Figure 3 shows the openness of the two regions as measured by real *per capita* imports. In Latin American countries, the openness degree was low and stable



Source: Penn World Table 9.0. Calculations by authors.

Figure 3. Real *per capita* imports in Latin America and Asia, 1950-2014.

until the end of the 1980s but increased thereafter. The openness degree of the Asian economies group is not quite different from that of Latin America, mainly because of the low levels of openness of the largest Asian economies (China and India), as well as that of Indonesia. However, real *per capita* imports have increased significantly since the early 1990s.

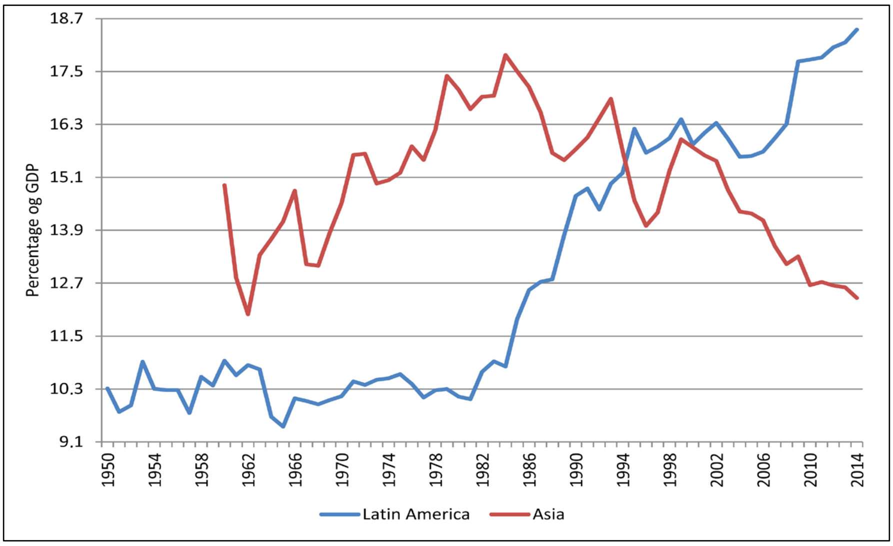
Other economies (Singapore and Hong Kong) have been historically rather open, at least in the period analyzed; or they registered a strong opening process starting from very low initial levels (South Korea and Thailand) or relatively low ones (Taiwan and Malaysia). These differences explain the high values of real imports as a percentage of GDP, or in Asian *per capita* terms, when calculated as the arithmetic average of the economies.

With regard to the importance of the public sector, it should be noted that while the government may play a beneficial role in the economy, it may also entail a heavy burden. This occurs when the government imposes high taxes on businesses, uses these revenues to sustain ineffective public programs and an inflated bureaucracy, distorts market incentives, and interferes negatively in the economy by assuming roles that are more appropriate for the private sector (Loayza, Fajnzylber, & Calderón, 2005). Akcigit et al. (2018) and Cai et al. (2018) have demonstrated, with statistical evidence, the negative effects of taxes on companies and innovators in innovating activities, which generates, sooner or later, higher multi-factor productivity.

The measure generally used to determine the government's weight in the economy is the ratio of government consumption to GDP. Although not all public consumption can be considered as an obstacle to growth (for instance, expenditure on health, education, and police), much of the government's current (or consumer) expenditure has no clear social return and is mainly spent on bureaucratic expenses (Loayza, Fajnzylber, & Calderón, 2005). A relevant distinction between consumption expenditures that are useful and those that are not useful for economic growth cannot be made, due to the lack of consistent data on these expenditure categories for the sample of selected economies. In any case, according to Barro and Lee (1994), public spending (consumption) can be a source of distortions in private decisions, thus negatively affecting productivity.[12]

One of the mechanisms through which the expansion of public spending can have a long-term depression effect on multifactorial productivity is to increase the opportunity cost of the material and human resources private companies can devote to projects with long-term effects, and which refer to what is called 'technical change' in a broad sense. By assuming that these resources have an alternative use, they should be devoted to immediate production in order to meet the demand induced by greater public spending. Posada (2015) has illustrated this possibility through an economic growth model marked by a specific factor: an endogenous technical improvement associated to the growing use of material and human resources with an opportunity cost similar to the one mentioned earlier. This reflection contributes to the foundation of our hypothesis on the negative effect of increased public consumption on TFP.

The evolution of the State size in the two regions has been clearly different. In Latin America, the share of public consumption in GDP remained virtually stagnant in the first three decades examined (1950-1980), if we consider the aggregate behavior of the countries in the region. In the following decades, it increased rapidly and steadily (Figure 4). This increase was virtually general for all



Source: Penn World Table 9.0. Calculations by authors.

Figure 4. Evolution of real public consumption expenditure/real GDP in Latin America and Asia, 1950-2014.

[12]The distortions associated with increasing public consumption may reflect those corresponding to government activities themselves (including the effects of political corruption) and also the adverse effects associated with distorting financing of public spending.

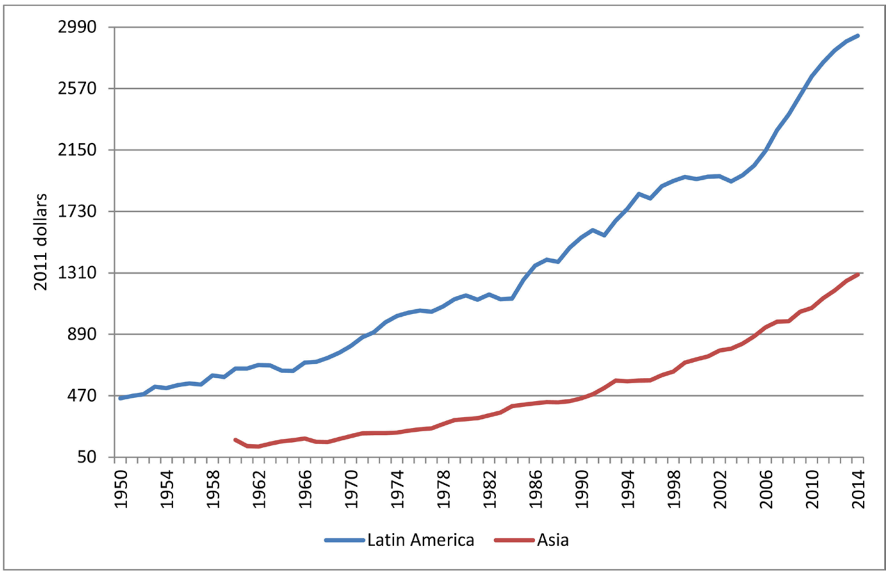
the countries.

In the case of Asian economies, the size of the State increased until the mid-1980s and then declined sharply. This initial increase was due to the enormous public consumption share of in the GDPs of Taiwan and South Korea, by virtue of the large military expenditure. Subsequently, the size of their governments returned to the pattern displayed by the Asian economies in this analysis. In summary, the public consumption share of GDP in Latin America was lower than in Asia until the mid-1990s and thereon higher.

Moreover, in the case of Latin America, there has been a sustained increase in real public consumption *per capita* over the long term, albeit in the midst of medium-term accelerations and decelerations (**Figure 5**). In the group of Asian economies, real *per capita* public consumption also increased steadily (**Figure 5**), although its levels are much lower than those of Latin America.

The relationship between public investment and growth has been the subject of broad debate since, at least, the work of Aschauer (1989), which can be considered the starting point of the main branch in the literature on this subject (De la Fuente, 2010).[13] Public investment can expand an economy's productive capacity, by increasing both the amount of resources available and the productivity of existing resources.

Various channels have been identified in the literature through which public investment can have positive effects on economic growth. Firstly, the public



Source: Penn World Table 9.0. Calculations by authors.

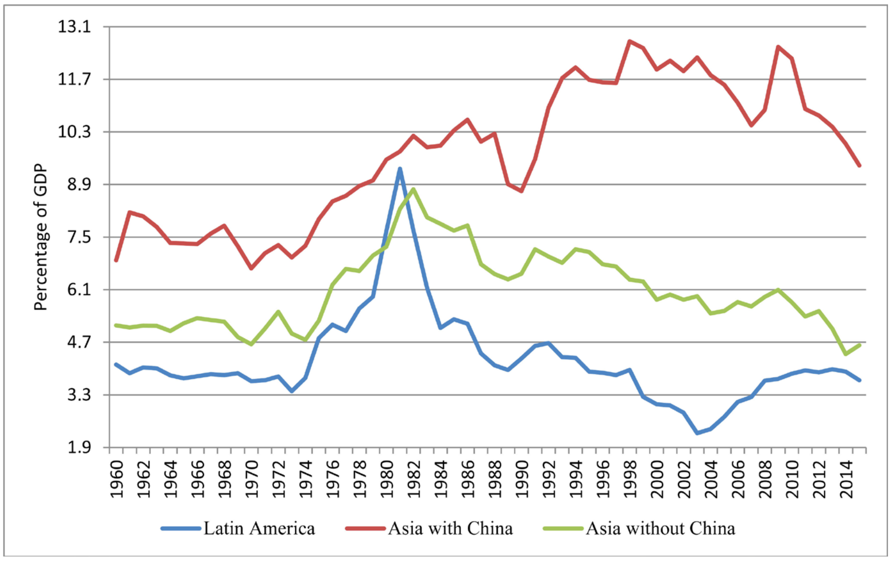
Figure 5. Evolution of real public consumption expenditure *per capita* in Latin America and Asia, 1950-2014.

[13]The argument related to the efficiency of public investment seems to gain relevance in current debates. This efficiency depends on the sensitivity of the product (in the short and long term) to productive investment and the public decision processes in terms of project selection, implementation and monitoring.

sector capital can be considered as something that must be incorporated into the production function as an additional factor. Secondly, public investment can also increase the willingness of the private sector to make further investments (crowding-in effect).[14] And finally, public investment can have effects on productivity due to externalities, increasing returns to scale and cost reductions (Straub, 2008).

Despite the many theoretical approaches that attempt to substantiate the causal relationship between public investment and economic growth, the empirical results on these effects are unclear, and many consider it as unproductive (Arslanalp, Bornhorst, & Gupta, 2011). Although the potential role of public infrastructure in improving productivity has been very prominent in recent years, the empirical evidence has been mixed at best (La Ferrara & Marcellino, 2000; Arslanalp, Bornhorst, Gupta, & Sze, 2010).[15] However, some relatively recent studies (The World Bank, 2007, for example) conclude that public spending on infrastructure, education and health has positive effects on growth. The report of the World Bank Commission on Growth and Development (2008) points out that fast-growing countries have a high level of public investment, 7% or more of GDP (Arslanalp, Bornhorst, & Gupta, 2011).

Figure 6 shows the evolution of public investment as a percentage of GDP in



Source: FMI (2016), Fiscal Affairs Department Investment and Capital Stock Dataset, 1960-2015.

Figure 6. Real share of public investment in GDP in Latin America and Asia, 1960-2015.

[14]The relationship between public and private investment is characterized by two opposite forces: on the one hand, public capital can increase productivity of private capital, by increasing its return rate and inducing a higher investment. On the other hand, from the perspective of the investor, public capital works as a substitute for the private capital and crowds out private investment (Munnell, 1992). Moreover, the likely positive effects of public infrastructure are significantly reduced as their financing ways are considered.

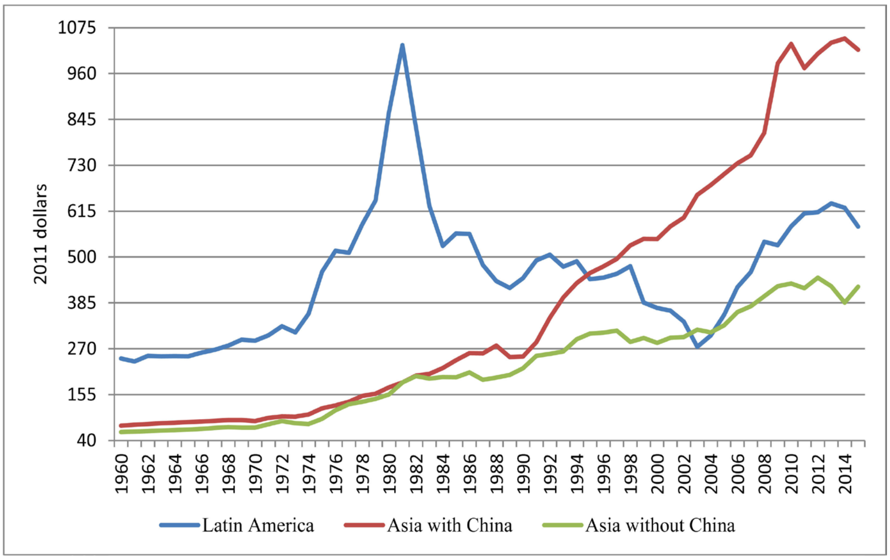
[15]This article reviews the results of a large part of the literature on the relationship between capital or public investment and economic growth published between the mid-1990s and the middle of the following decade.

real terms for the economies considered in Latin America and Asia. As can be seen, public investment in Latin America has averaged close to 4% of GDP, amidst fluctuations of varying intensity. In the case of Asian economies, it seems appropriate to show the evolution by including and excluding China. **Figure 6** also illustrates the great importance of public investment in China, mainly since the early 1980s. In fact, the upward trend in the Asian public investment rate over these five and a half decades is explained by China.

Figure 6 shows the real public investment rate as GDP percentages for these economies. While the Asian economy, including China, shows a marked upward trend for the whole period, the Asian economies, without China, and Latin America show a growing pattern until the 80s, which changes to a decline pattern until 2015. It can also be observed that, when excluding China, the real share of public investment in GDP was lower and presented a clear decline since the early 1980s. In every case, it is clear that the relative importance of public investment has been greater in the group of Asian economies than in Latin American countries. However, this difference seems to be a manifestation of the gap in the factor accumulation rate between the two regions, which is, as Fernandez-Arias (2017) indicates, more of a peculiarity in East Asian development than a Latin American weakness.

Real public investment *per capita* in Latin America rose sharply in the 1970s. Then, amidst slight fluctuations, it contracted dramatically during the debt crisis of the 1980s until the beginning of the last decade, when it rose sharply again (**Figure 7**). This evolution was similar to that experienced by the share of public investment in GDP.

Real public investment *per capita* in Asia shows a clear increasing trend, mainly since the 1990s, due to its strong expansion in China. As a result, Asian



Source: FMI (2016), Fiscal Affairs Department. Investment and Capital Stock Dataset, 1960-2015.

Figure 7. Real public investment *per capita* in Latin America and Asia, 1960-2015.

public investment (including China) *per capita* has been above that of Latin America since the second half of the 1990s (**Figure 7**). In contrast, when excluding China, public investment *per capita* has also been increasing, but at a historically lower rate than in Latin America.

3. The Econometric Exercise and the Results

Based on the previously discussed hypotheses, we proposed to estimate a panel cointegration model (data from a set of economies over time), which permits to assess the hypothetical long-term relationships between the dependent variable (multifactorial productivity of each country *i* in each period *t* of the time horizon) and the following explanatory variables: public spending (public consumption), public investment, imports and exports, by expressing the explanatory variables as percentages of GDP or in *per capita* terms (each variable for each country in each period).[16] Evidence of cointegration between these last two variables raised a problem since introducing both of them into a model would generate a problem of redundant variables. Therefore it has been relevant to introduce only one of them. In this case, imports are used as the openness indicator of an economy.

Several panel data unit root tests were generally favorable to the existence of stochastic tendency (panel). The first and second generation conventional tests have supported this behavior (Breitung & Pesaran, 2005; Hurlin & Mignon, 2007), as well as the PANIC tests (Bai & Ng, 2002, 2004, 2010; Pesaran, 2007), which show the existence of a panel unit root caused by the presence of at least one common factor that leads to such behavior in the series of the group of economies analyzed (Annex 5 shows the results of these tests).[17]

Annex 1 (**Table A.1.1**) presents the results of the import/export cointegration tests (as percentage of GDP), as well as those of the cointegration tests between TFP and its [assumed] determining variables as proportions of GDP and in *per capita* terms within models with a deterministic trend (**Table A.1.2**).

The cointegration equation to be estimated within the "cointegration and error correction vector" (ECV) with explanatory variables measured as percentage of GDP is as follows:

$$\log\left(TFP_{it}\right)=\beta_0+\beta_1\log\left(GGDP_{it}\right)+\beta_2\log\left(IGGDP_{it}\right)+\beta_3\log\left(MGDP_{it}\right)+\beta_4 t$$

And with *per capita* variables, it is as follows:

$$\log\left(TFP_{it}\right)=\beta_0+\beta_1\log\left(G_{it}\right)+\beta_2\log\left(IG_{it}\right)+\beta_3\log\left(M_{it}\right)+\beta_4 t$$

Table 1 shows the results of the cointegration exercise for the proposed models considering the 16 selected economies, i.e. including China. In all the esti-

[16]The construction of the dependent variable (TFP) in this work makes it inadequate to include the variable "human capital" or level of education among the explanatory variables in the equation to be estimated.

[17]An application of the PANIC tests for the Japanese economy is found in Shibamoto, Tsutsui, and Yamane (2016). Conventional first and second-generation tests are in R modules that are available on the internet: Croissant and Millo (2008), Kleiber and Lupi (2011), Lupi (2011) and Bronder (2015).

mated models (columns A and B), the signs of the estimated coefficients for public spending and public investment are the expected, negative and positive respectively, as is the proxy for economic openness.[18] For the variables as percentage of GDP (column A), the public spending coefficient (public consumption/GDP) is significant at certain conventional levels of significance. With respect to the public investment coefficient, some relaxation of the criteria would be required in order to reject the null hypothesis: Ho = 0. On the other hand, the rate of imports (imports/GDP) and the deterministic trend were not significant. In contrast, for variables in *per capita* terms (column B), the estimated coefficients are significantly different from zero for conventional significance levels for all

Table 1. Estimation results of cointegration models including China.

Dependent variable: Log TFP		
Independent variable:	**A. Percentage of GDP**	**B. *Per capita***
Log (public consumption): *LG*	−0.690066* [−4.19086]	−0.593109* [−3.75748]
Log (public investment): *LIG*	0.147636 [1.44583]****	0.280652** [2.39343]
Log (imports): *LM*	0.020417 [0.25688]	0.173842*** [1.93741]
Trend (initial year 1960)	−0.000148 [−0.38153]	−0.000383 [−1.05744]
Constant	5.960275	5.778675
Determinant resid covariance (dof adj.)	4.08E−09	3.89E−09
Determinant resid covariance	3.97E−09	3.71E−09
Log likelihood	3389.438	3353.193
Akaike information criterion	−7.925562	−7.952387
Schwarz criterion	−7.763365	−7.696891
Adjustment coefficients		
alpha 1	−0.032384* [−6.92493]	−0.025891* [−6.59271]
alpha 2	−0.004961 [−1.03658]	−0.020946* [−5.35026]
alpha 3	0.017037 [1.59783]	−0.002611 [−0.27082]
alpha 4	−0.000177 [−0.01920]	−0.018276** [−2.01146]

Note: The t-values are in square brackets. The significance levels of 1%, 5%, 10% and 20% are indicated by one, two, three and four asterisks, respectively.

[18]Moderate estimates of public spending inefficiencies (inefficiencies in procurement, payroll spending and targeted transfers) in Latin America and the Caribbean stand at 4.4% of GDP in 2015-2016 (Inter-American Development Bank, 2018). Andrade, Gaspar and Bittencourt (2014) use a stochastic frontier model to examine and decompose TFP in Latin America during 1960-2010, concluding that the high share of government current expenditure in the composition of aggregate expenditure in Latin American countries leads to economic inefficiency.

variables, except for the deterministic trend, which is not significant under any acceptable significance level (columns A and B).

Including China could be objected due to the fact that between 1949 and 1978 it was an economy without private companies, its size, and importance within the Asian economies in the sample. Table 2 contains results of cointegration exercises excluding China. The results are broadly similar to those in Table 1, except for *per capita* imports, where some easing of the criteria was necessary to reject the null hypothesis: Ho = 0, and the case of the deterministic trend, since its coefficient is practically zero in this exercise (column B).

The results in Table 1 and Table 2 imply that the negative effect of public consumption is not offset by the positive effect of public investment; indeed, in columns A and B of Table 1 it can be seen that the relative effect of public investment (the ratio of its coefficient to that of public consumption) is, at most, 47.3% (column B); while in columns A and B of Table 2, the relative effect of

Table 2. Estimation results of cointegration models excluding mainland China.

Dependent variable: Log TFP		
Independent variable:	**A. Percentage of GDP**	**B. *Per capita***
Log (public consumption): *LG*	−0.72642* [−4.22412]	−0.814318* [−5.19468]
Log (public investment): *LIG*	0.203577*** [1.71819]	0.546306* [4.26199]
Log (imports): *LM*	−0.016385 [−0.18674]	0.14147**** [1.39349]
Trend (initial year 1960)	−0.00017 [−0.37265]	−0.000915 [−2.25671]**
Constant	6.102227	6.205452
Determinant resid covariance (dof adj.)	3.97E−09	4.25E−09
Determinant resid covariance	3.85E−09	4.13E−09
Log likelihood	3189.309	3161.951
Akaike information criterion	−7.950462	−7.881638
Schwarz criterion	−7.779805	−7.710981
Adjustment coefficients		
alpha 1	−0.02964* [−6.30310]	−0.019958* [−5.43227]
alpha 2	−0.00677 [−1.39669]	−0.020189* [−5.43967]
alpha 3	0.020548*** [1.85256]	0.012336 [1.34119]
alpha 4	0.001967 [0.21192]	−0.00419 [−0.48932]

Note: The t-values are in square brackets. The significance levels of 1%, 5%, 10% and 20% are indicated by one, two, three and four asterisks, respectively.

public investment is, at most, 67.1% (column B) of the impact of public consumption.[19]

Table 1 and Table 2 also show the adjustment coefficients (α_j) and their corresponding t values, in order, of the logarithm of TFP and the logarithms of the explanatory variables (public consumption, public investment and imports), both measured as a percentage of GDP (column A) and in *per capita* terms (column B), including and excluding China.[20] This statistical evidence allows testing whether or not the model variables are endogenous, which is equivalent to testing the null hypothesis $\alpha_j = 0$ against the alternative hypothesis $\alpha_j \neq 0$.

The results show that, in all cases, empirical evidence (at conventional statistical significance levels) supports the weak endogeneity of TFP. On the other hand, the adjustment coefficients of the explanatory variables as a percentage of GDP seem to lean more towards the weak exogeneity of public consumption, public investment and imports. In contrast, the adjustment coefficients of the variables in *per capita* terms show that public spending and imports also seem to react endogenously to the departures of the TFP from its long-term equilibrium when China is included, while public investment seems to be weakly exogenous. Excluding China, *per capita* public consumption would also react endogenously, while *per capita* public investment and *per capita* imports appear to be weakly exogenous.

Another estimation exercise consists of imposing regional dummies defined as follows: Asia (dummy = 0) or Latin America (dummy = 1). These dummies allow capturing the change of slope in the cointegrating relationships for Latin America, differentiating them in the same estimation from those of Asia. Table 3 presents the results of these estimates for the variables as a proportion of GDP and in *per capita* terms for all economies, while the results of the estimates for the group of economies excluding China are shown in Table 4.

The results obtained for the variables measured as proportions of GDP are quite consistent with the results shown in Table 1 and Table 2: public consumption has a negative effect which, in absolute value, is up to three times the value of the positive effect of public investment, i.e. the positive effects of public investment are not large enough to offset or reverse the negative effects of public consumption on TFP. Imports (which we use as the best variable to approach economic openness) generally have a positive effect that is not statistically significant. The deterministic trend does not seem to be an important determinant in this exercise, although for Latin American countries it has a negative sign. This reflects the decreasing trend of TFP in this region, as previously documented in this article.

In *per capita* terms, the expected signs for public consumption and investment

[19]This article does not aim to determine the optimal size of public spending. Evidence has been found in the literature of an inverse parabolic relationship between the size of public spending and economic growth. In this regard, the results of Posada and Escobar (2004) and Posada and Gómez (2002) can be considered.

[20]The signs of the coefficients α_j indicate the direction or sense of the adjustment.

Table 3. Estimation results of cointegration models with regional dummies including China.

Dependent variable: Log TFP				
Independent variables	**Percentage of GDP**		***Per capita***	
	All	**Latin America**	**All**	**Latin America**
Log (public consumption): *LG*	−2.117895*	−0.300467	−0.78601*	−0.108824
	[−7.87052]		[−5.95696]	
Log (public investment): *LIG*	0.698088*	0.13285	0.251655**	0.120606
	[3.62107]		[2.22520]	
Log (imports): *LM*	0.088724	0.164454	0.291973*	0.212975
	[0.81718]		[5.00668]	
DUM_REG*LGPIB	1.817428*		0.677186*	
	[4.34998]		[3.57364]	
DUM_REG*LIGPIB	−0.565238**		−0.131049	
	[−2.28820]		[−0.96222]	
DUM_REG*LMPIB	0.07573		−0.078998	
	[0.29319]		[−0.58597]	
Trend (initial year 1960)	0.002442	−0.019561	0.01046**	−0.025087
	[0.35622]		[2.48781]	
DUM_REG*TIEMPO	−0.022003***		−0.035547*	
	[−1.87463]		[−5.14054]	
Determinant resid covariance (dof adj.)	4.25E−77		6.83E−76	
Determinant resid covariance	3.82E−77		6.14E−76	
Log likelihood	65475.2		65196.25	
Akaike information criterion	−154.1892		−153.5312	
Schwarz criterion	−153.6354		−152.9775	
Adjustment Coefficients				
alpha 1	−0.008084**		−0.034519*	
	[−2.27783]		[−5.77802]	
alpha 2	−0.016294*		−0.019104*	
	[−6.52661]		[−4.03264]	
alpha 3	0.006071		0.011845	
	[1.25733]		[1.35129]	
alpha 4	0.015041*		0.023532**	
	[3.44586]		[2.58058]	

Note: t values are in square brackets. The significance levels of 1%, 5%, 10% and 20% are indicated by one, two, three and four asterisks, respectively.

Table 4. Estimation results of cointegration models with regional dummies excluding China.

Dependent variable: Log TFP				
Independent variables	**GDP percentage**		***Per capita***	
	All	**Latin Am.**	**Asia**	**Latin Am.**
Log (public spending): *LG*	−2.938516*	−0.275916	−1.235985*	−0.109866
	[−8.53294]		[−7.03479]	
Log (public investment): *LIG*	1.632265*	0.146014	0.484514*	0.1229
	[5.42014]		[3.28599]	
Log (imports): *LM*	−0.217724****	0.168652	0.401786*	0.212018
	[−1.33729]		[5.38025]	
DUM_REG*LGPIB	2.6626*		1.126119*	
	[4.89859]		[4.59117]	
DUM_REG*LIGPIB	−1.486251*		−0.361614**	
	[−4.16271]		[−2.05842]	
DUM_REG*LMPIB	0.386376		−0.189768	
	[1.21830]		[−1.11493]	
Trend (year one: 1960)	0.010887	−0.020291	0.00795****	−0.02493
	[1.18676]		[1.44271]	
DUM_REG*TIEMPO	−0.031178**		−0.03288*	
	[−2.24810]		[−3.72004]	
Determinant resid covariance (dof adj.)	3.20E−76		6.63E−76	
Determinant resid covariance	2.86E−76		5.92E−76	
Log likelihood	61757.35		60832.38	
Akaike information criterion	−155.1154		−152.7884	
Schwarz criterion	−154.5328		−152.2058	
Adjustment coefficients				
alpha 1	−0.003605		−0.017844*	
	[−1.33759]		[−3.72807]	
alpha 2	−0.012951*		−0.014316*	
	[−6.87216]		[−3.71357]	
alpha 3	0.009577**		0.011445	
	[2.55951]		[1.66943]	
alpha 4	0.01129*		0.030135*	
	[3.60262]		[4.30811]	

Note: t values are in square brackets. The significance levels of 1%, 5%, 10% and 20% are indicated by one, two, three and four asterisks, respectively.

remain: negative for consumption and positive for investment in all economies. However, in the case of Latin America, the positive effect of the latter is slightly greater than the negative effect of consumption. Imports have a positive effect for Asia and Latin America, although for the latter it is not statistically significant. The time trend is negative and significant for Latin America, but this time it is positive and significant for Asia.

The adjustment coefficients in the lower panel of Table 3 and Table 4 show interesting short-term dynamics that go hand in hand with our main hypothesis. The α_1 coefficients show the short-term adjustment of the TFP variable as it departs from the long-term relationship contained in the cointegration vector and its respectively subsequent endogeneity. In other words, in this exercise not only can the long-term relationship between TFP and the variables considered be identified and estimated, but evidence of the endogeneity of TFP can also be extracted.[21] A surprising result, in line with our initial hypothesis, is the endogeneity of public consumption (reflected in the α_2 statistically significant coefficients), which suggests that this is an automatic stabilizer. This means that it seems to work as a short-term buffer, but with negative effects in the long term. For its part, public investment is exogenous (which is reflected in the α_3 coefficients), and thus statistically significant. Then, this can result from decisions that have a distant relationship with the economic cycle, but rather with decisions that affect the long-term dynamics and structure of economies. Finally, imports appear to be endogenous, thus suggesting that openness, measured in terms of imports, would be more of an outcome than a cause of TFP growth.

4. Summary and Conclusion

At the beginning of the 1960s, the set of nine Central-East Asian economies that are now considered as successful economies (China Mainland, Hong Kong, Taiwan, South Korea, India, Indonesia, Malaysia, Singapore, and Thailand) had a lower *per capita* income than the set of (at that time) the seven main Latin American economies (Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela). In the second decade of the 21st century, the gap disappeared. Why? Several economists have rightly pointed out that what *prima facie* explains this development—which was undoubtedly unforeseen by overseers 60 years ago—has been primarily the different evolution of the TFP (i.e. it has been much faster in Central-East Asia than in Latin America) and, secondarily, the intensity with which the two basic production factors—physical and human capitals—have accumulated, which are higher in Central-East Asia and lower in Latin America.

The objective of this study was to try to understand what might explain the greater or lesser TFP growth rate in the economies of both regions. Our scope was not (nor did it attempt to be) deep enough to reach the so-called "root caus-

[21]TFP does not pass the endogeneity test only in the estimation with regional dummies excluding China and as a percentage of GDP.

es". However, we managed to find statistical evidence, derived from an econometric exercise favorable to one hypothesis: the increase in public consumption expenditure, given the evolution of other factors, is a depressing factor for TFP in the long term. This hypothesis certainly partakes theoretical support and, according to our econometric results, could still be considered plausible.

Other results of the econometric exercise, which are related to hypothetical positive effects of public investment and imports on TFP, were in some cases not as robust or as reliable as they might have been expected. Therefore, in light of the econometric results, we can conclude that if the Latin American economies had slowed down public consumption, by limiting it to what was required to guarantee the rule of law, national sovereignty and universal coverage in basic education and health, their *per capita* income would probably have risen much higher and the old gaps between them and the East Asian economies would have been maintained or attended more favorably.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Annex 1. Cointegration and Estimation Tests Results of "Cointegration Vector and Error Correction"

Table A.1.1. Cointegration tests for imports/GDP and exports/GDP (LMPIB and LXPIB)

Specification: linear deterministic trend					
Region	Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
Asia	None	34.3	0.0116	30.51	0.0328
	At most 1	16.34	0.5691	16.34	0.5691
Latam	None	20.19	0.1244	18.28	0.1945
	At most 1	10.91	0.6927	10.91	0.6927
All	None	48.59	0.0303	44.52	0.0697
	At most 1	25.35	0.7914	25.35	0.7914
Specification without linear deterministic trend					
Region	Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
Asia	None	50.67	0.0001	45.66	0.0003
	At most 1	27.45	0.0709	27.45	0.0709
Latam	None	26.27	0.0239	24.78	0.0368
	At most 1	17.25	0.2431	17.25	0.2431
All	None	65.73	0.0004	63.33	0.0008
	At most 1	38.13	0.2105	38.13	0.2105

Table A.1.2. Cointegration tests results for variables (in logarithms): TFP, public consumption/GDP, public investment/GDP and imports/GDP, LPTF, LGPIB, LIGPIB and LMPIB (including China).

Specification: linear deterministic trend					
Variables	Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	0 Prob.	Fisher Stat.* (from max-eigen test)	0 Prob.
GDP %	None	110.2	0	76.63	0
	At most 1	54.4	0.008	38.07	0.2126
	At most 2	35.36	0.3125	24.75	0.8159
	At most 3	27.76	0.6813	27.76	0.6813
per capita	None	132.6	0	115.9	0
	At most 1	49.47	0.0251	41.78	0.1156
	At most 2	26.2	0.7545	21.95	0.9087
	At most 3	21.88	0.9105	21.88	0.9105

Annex 2. Endogeneity vs Exogeneity

Equation models (A1) and (A2) correspond to VEC models estimated for *per capita* variables or as GDP proportions in this exercise.

$$\begin{bmatrix} \Delta\log(PTF_{it}) \\ \Delta\log(GPIB_{it}) \\ \Delta\log(IGPIB_{it}) \\ \Delta\log(MPIB_{it}) \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \end{bmatrix} + \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{bmatrix} \begin{bmatrix} 1 & \beta_0 & \beta_1 & \beta_2 & \beta_3 & \beta_4 \end{bmatrix} \begin{bmatrix} \log(PTF_{it-1}) \\ 1 \\ \log(GPIB_{it-1}) \\ \log(IGPIB_{it-1}) \\ \log(MPIB_{it-1}) \\ t-1 \end{bmatrix} + \begin{bmatrix} \pi_{11} & \pi_{12} & \pi_{13} & \pi_{14} \\ \pi_{21} & \pi_{22} & \pi_{23} & \pi_{24} \\ \pi_{31} & \pi_{32} & \pi_{33} & \pi_{34} \\ \pi_{41} & \pi_{42} & \pi_{43} & \pi_{44} \end{bmatrix} \begin{bmatrix} \Delta\log(PTF_{it-1}) \\ \Delta\log(GPIB_{it-1}) \\ \Delta\log(IGPIB_{it-1}) \\ \Delta\log(MPIB_{it-1}) \end{bmatrix} + \begin{bmatrix} \varepsilon_{1it} \\ \varepsilon_{2it} \\ \varepsilon_{3it} \\ \varepsilon_{4it} \end{bmatrix} \quad \text{(A1)}$$

And in *per capita* terms:

$$\begin{bmatrix} \Delta\log(PTF_{it}) \\ \Delta\log(GPIB_{it}) \\ \Delta\log(IGPIB_{it}) \\ \Delta\log(MPIB_{it}) \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \end{bmatrix} + \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{bmatrix} \begin{bmatrix} 1 & \beta_0 & \beta_1 & \beta_2 & \beta_3 & \beta_4 \end{bmatrix} \begin{bmatrix} \log(PTF_{it-1}) \\ 1 \\ \log(G_{it-1}) \\ \log(IG_{it-1}) \\ \log(M_{it-1}) \\ t-1 \end{bmatrix} + \begin{bmatrix} \pi_{11} & \pi_{12} & \pi_{13} & \pi_{14} \\ \pi_{21} & \pi_{22} & \pi_{23} & \pi_{24} \\ \pi_{31} & \pi_{32} & \pi_{33} & \pi_{34} \\ \pi_{41} & \pi_{42} & \pi_{43} & \pi_{44} \end{bmatrix} \begin{bmatrix} \Delta\log(PTF_{it-1}) \\ \Delta\log(G_{it-1}) \\ \Delta\log(IG_{it-1}) \\ \Delta\log(M_{it-1}) \end{bmatrix} + \begin{bmatrix} \varepsilon_{1it} \\ \varepsilon_{2it} \\ \varepsilon_{3it} \\ \varepsilon_{4it} \end{bmatrix} \quad \text{(A2)}$$

In a more compact and general way, these models can be written as:

$$\Delta Y_{it} = \Gamma + \Pi_0 Y_{it-1} + \sum_{k=1}^{p} \Pi_k \Delta Y_{it-k} + \varepsilon_{it} \quad \text{(A3)}$$

$$\Delta Y_{it} = \Gamma + \alpha\beta Y_{it-1} + \sum_{k=1}^{p} \Pi_k \Delta Y_{it-k} + \varepsilon_{it} \quad \text{(A4)}$$

Being $\Pi_0 = \alpha\beta$

The row vector β shows the cointegration vector or long run relationship, while column vector α shows the adjustment speeds (and signs or directions) of growth rates of the dependent variables when their movement (in period $t-1$) moved them away from their stationary state or long run situation. For their part, matrices Π_k include the effects of ΔY_{it-k}, $k = 1,2,3,\cdots,p$ on the evolution of the existing growth rates of variables. Intuitively, if a variable *j* reacts (its behavior is induced) by the distances or deviations regarding the long run, it is said that this variable responds endogenously to the behavior of the others, which occurs when its adjustment coefficient α_j is different from zero. But when the value of α_j is zero, the growth rate is explained only by the dynamics of the lags of the other variables and of itself. Then, there is no long run dynamics, therefore the model contained in expressions (A1) to (A4) takes the form of a VAR in first differences. In this case, it is claimed that this variable is weakly exogenous or that there is evidence of weak endogeneity. The notion of "weak" arises because this form of VAR in first differences shows the causal relations that can exist between differentiated variables.

Annex 3. Aggregate Productivity and Public Spending

The standard estimate of aggregate productivity (TFP) considers annual production Y (measured by GDP) and estimates of available accumulated factors of production. These are the physical capital and the human capital. TFP measures the efficiency by which accumulated production factors are used to generate the product. The contributions of factors of production and TFP to the product are estimated using a relevant production function. The Cobb-Douglas production function we use has the following form:

$$Y = K^{\alpha} \left(AhL\right)^{1-\alpha} \tag{1}$$

Being K the stock of physical capital, hL the number of workers (L) multiplied by the index of human capital per worker (h); A is total factor productivity and α is product's elasticity with respect to physical capital.

The parameter of the production function (α) is set at 0.434 (Fernández-Arias, 2014).[22] Although there is some debate about the validity of this assumption of uniformity, Gollin (2002) shows that once informal work and family businesses are taken into account, there is no systematic difference between countries that could be associated with their levels of development (GDP *per capita*), nor with any time trend. Therefore, its uniformity between countries and over time seems to be a reasonable assumption. This assumption also implies that any technological change that has occurred since 1960 is reflected in measure A of multifactor productivity (Fernández-Arias, 2017).

Equation (1) implies:

$$A = \left[\frac{Y}{K^{\alpha}\left(hL\right)^{1-\alpha}}\right]^{\frac{1}{1-\alpha}} \tag{2}$$

TFP (variable A in equation 2) is a residual that can reflect advances in technology (the "instructions" for producing goods and services) and those arising from changes in micro efficiency or the general economic environment in which production takes place, efficiency in the functioning of markets,[23] externalities,

[22]This value corresponds to the average of the cross-country elasticities estimated in 1960 (the base year) in Penn World Tables 8.0 (Fernandez-Arias, 2014).

[23]For instance, policies can distort the efficiency with which factors are allocated across sectors and across companies within sectors, thus reducing efficiency at the aggregate level.

increasing returns and economies of scale, changes in the composition of productive sectors, and the adoption of lower-cost production methods. Consequently, TFP is a comprehensive (broad) measure of efficiency whereby the economy can transform its accumulated factors of production into production (Fernández-Arias, 2017).

Annex 4. Sources of Data to Build TFP and for the Analysis of Its Determinants

Table A.4. Sources and databases.

Variable	Description	Source
Y	Real GDP at constant 2011 national prices (in millions 2011 US$)	PWT 9.0
K	Capital stock at constant 2011 national prices (in millions 2011 US$)	PWT 9.0
L	Number of persons engaged (in millions)	PWT 9.0
h	Human capital index per person, based on years of schooling and returns to education.	PWT 9.0
Population	Population Level (000 at midyear)	Maddison Database
C_g/Y	Government consumption/GDP, both at constant national 2011 prices	PWT 9.0
M/Y	Imports/GDP, both at constant national 2011 prices	PWT 9.0
I_g/Y	General government investment (gross fixed capital formation)/ GDP, both in billions of constant 2011 international dollars	FMI, Fiscal Affairs Department

In the case of Argentina, data from Real GDP at constant national prices (in millions 2011 US$) were constructed based on growth rates reported in The Conference Board—Total Economy Database, based on Real GDP in 2011 obtained from PWT 9.0. The physical capital stock is calculated from the capital-output ratio of the PWT 9.0 data. Similarly, the employment data were taken from The Conference Board—Total Economy Database (persons employed). The share of government consumption in GDP corresponds to its nominal values in national currency according to PWT 9.0.

Public spending

The share of public spending in the GDP of the economies described below does not correspond to that of the other economies in the sample, due to the problems observed in the series obtained from PWT referenced in the table above.

In Brazil, the share of government consumption in GDP is calculated as the average of the shares at constant prices (corrected by own calculations) and at current prices, both in national currency, reported by ECLAC.

In Mexico, the share of government consumption in GDP corresponds to data reported by PWT 9.0 as *csh_g*: *Share of government consumption at current PPPs.*

In Venezuela, the share of government consumption in GDP is calculated by correcting the inflation rates of the implicit deflators of government consumption expenditures in national currency for some years that PWT shows, assuming that they are equal to the inflation rates of the GDP deflators. This correction makes it possible to obtain a series of such expenditures in real terms in national currency and thus the share of public consumption in GDP at constant prices in national currency during the period 1950-1997. The share of public consumption in GDP at constant prices for the period 1997-2014 was obtained from ECLAC and then linked backwards (1950-1996) to the growth rates of the corrected real share.

Finally, the shares of public consumption in the GDP of all economies are multiplied by *Real GDP at constant* 2011 *national prices* (*in millions* 2011 *US$*) from PWT 9.0 to obtain the public consumption in *constant* 2011 *national prices* (*in millions* 2011 *US$*), thereby obtaining the corresponding figures in *per capita* terms.

Annex 5. Estimates Using TFP Calculated with Product to Capital Elasticities ("α") Which Differ by Country and Over Time

The stability of factor share in income has been a fundamental basis for macroeconomic models since Kaldor's famous stylized facts (1957). As is known, this restriction has important macroeconomic implications. However, in the last two decades some works have found an important variability in labor share in the medium term and a downward trend in the last three or four decades. For instance, Karabarbounis and Neiman (2014) find a significant decline in global labor share since the early 1980s. This decline is observed in most countries and industries. Likewise, thorough estimates of labor share included in the new version of Penn World Tables show a similar trend (Feenstra, Inklaar, & Timmer, 2015).

This annex presents the results of the cointegration exercise using the TFP index for the sample countries reported by PWT 9.0 but calculated using different shares between countries and over time.

Table A.5.1 (including China) shows that none of the variables as a percentage of GDP was significant as a determinant of multifactor productivity. In contrast, in *per capita* terms, the signs of the estimated coefficients for public spending (consumption), imports, and public investment are as expected: Negative for the former and positive for the latter two. The coefficients of public spending and imports are significant at conventional levels of significance, while public investment is significant at levels of significance of 10%. For its part, the deterministic trend was not significant.

Table A.5.1. Results of cointegration models including China.

	Variables	A Percentages of GDP	B *Per capita*
Cointegration vectors	LPTFNUEVA (−1)	1	1
	LG (−1)	−0.009862	0.298708*
		[−0.09862]	[3.57830]
	LIG (−1)	0.021308	−0.113861
		[0.33866]	[−1.82979]***
	LM (−1)	−0.017952	−0.101159
		[−0.35281]	[−2.13430]**
	@TREND (60)	−0.000172	0.000155
		[−0.72149]	[0.80693]
	C	−4.38246	−5.224349
	Determinant resid covariance (dof adj.)	1.30E−09	1.25E−09
	Determinant resid covariance	1.26E−09	1.19E−09
	Log likelihood	3.87E+03	3.83E+03
	Akaike information criterion	−9.07E+00	−9.09E+00
	Schwarz criterion	−8.91E+00	−8.83E+00
	alpha 1	−0.031442	−0.028595
		[−7.25168]	[−6.77584]
	alpha 2	0.02613	−0.037336
		[3.33755]	[−4.94184]
	alpha 3	0.021073	−0.00709
		[1.18730]	[−0.38253]
	alpha 4	−0.024255	−0.043729
		[−1.56836]	[−2.50714]

Note: t values are in square brackets. The significance levels of 1%, 5% and 10% are indicated by one, two and three asterisks, respectively.

When the exercise was repeated excluding China (Table A.5.2), the effect of public spending on consumption on TFP was significant, whether the variable is measured as a proportion of GDP or in *per capita* terms.

Table A.5.2. Results of cointegration models excluding China.

	Variables	A Percentages of GDP	B *Per capita*
Cointegration vectors	LPTFNUEVA (−1)	1	1
	LG (−1)	0.214224**	0.262913*
		[2.37516]	[3.27817]
	LIG (−1)	−0.019648	−0.113747
		[−0.31556]	[−1.91314]***

Continued

LM (−1)	0.010318	−0.094089**
	[0.22370]	[−2.08902]
@TREND (60)	−0.000113	0.000261
	[−0.47249]	[1.31359]
C	−5.014693	−5.078706
Determinant resid covariance (dof adj.)	1.25E−09	1.24E−09
Determinant resid covariance	1.21E−09	1.18E−09
Log likelihood	3.65E+03	3.59E+03
Akaike information criterion	−9.11E+00	−9.09E+00
Schwarz criterion	−8.93E+00	−8.82E+00
alpha 1	−0.036674	−0.029783
	[−7.07928]	[−6.42945]
alpha 2	0.01037	−0.037166
	[1.07751]	[−4.33697]
alpha 3	0.033386	−0.007474
	[1.51627]	[−0.35567]
alpha 4	−0.020353	−0.048309
	[−1.10413]	[−2.45459]

Note: t values are in square brackets. The significance levels of 1%, 5% and 10% are indicated by one, two and three asterisks, respectively.

Annex 6. Unit Root Tests (Individual Deterministic Trends and Constants)

Table A.6.1. Unit root tests, TFP and *per capita* variables

Variable	Test	Statistic	Prob**	Cross-sections	Obs
LPTF		Ho: Unit root (common unit root)			
	Levin, Lin & Chu t*	−2.34285	0.0096	16	859
	Breitung t-stat	0.1383	0.555	16	843
		Ho: Unit root (individual unit root)			
	Im, Pesaran and Shin W-stat	−0.95658	0.1694	16	859
	ADF—Fisher Chi-square	34.631	0.3434	16	859
	PP—Fisher Chi-square	35.5284	0.3055	16	864
LG		Ho: Unit root (common unit root)			
	Levin, Lin & Chu t*	1.35975	0.913	16	854
	Breitung t-stat	1.33092	0.9084	16	838
		Ho: Unit root (individual unit root)			

Continued

	Im, Pesaran and Shin W-stat	0.38666	0.6505	16	854
	ADF—Fisher Chi-square	47.3558	0.0394	16	854
	PP—Fisher Chi-square	64.6822	0.0005	16	864
LIG		Ho: Unit root (common unit root)			
	Levin, Lin & Chu t*	0.32254	0.6265	16	852
	Breitung t-stat	0.55855	0.7118	16	836
		Ho: Unit root (individual unit root)			
	Im, Pesaran and Shin W-stat	0.11649	0.5464	16	852
	ADF—Fisher Chi-square	34.0647	0.3685	16	852
	PP—Fisher Chi-square	18.1863	0.9761	16	864
LM		Ho: Unit root (common unit root)			
	Levin, Lin & Chu t*	0.01066	0.5043	16	859
	Breitung t-stat	0.88557	0.8121	16	843
		Ho: Unit root (individual unit root)			
	Im, Pesaran and Shin W-stat	0.43151	0.6669	16	859
	ADF—Fisher Chi-square	29.9636	0.57	16	859
	PP—Fisher Chi-square	39.1414	0.1799	16	864

Table A.6.2. Unit root tests, variables as GDP proportion.

Variable	Test	Statistic	Prob**	Cross-sections	Obs
LGPIB	Ho: Unit root (common unit root)				
	Levin, Lin & Chu t*	−1.0576	0.1451	16	838
	Breitung t-stat	−1.3449	0.0893	16	822
	Ho: Unit root (individual unit root)				
	Im, Pesaran and Shin W-stat	−1.31808	0.0937	16	838
	ADF—Fisher Chi-square	43.5176	0.0842	16	838
	PP—Fisher Chi-square	38.8259	0.1891	16	864
LIGPIB	Ho: Unit root (common unit root)				
	Levin, Lin & Chu t*	−1.00081	0.1585	16	858
	Breitung t-stat	−1.16582	0.1218	16	842
	Ho: Unit root (individual unit root)				
	Im, Pesaran and Shin W-stat	−1.2211	0.111	16	858
	ADF—Fisher Chi-square	43.0943	0.0911	16	858
	PP—Fisher Chi-square	28.712	0.6337	16	864
LMPIB	Ho: Unit root (common unit root)				
	Levin, Lin & Chu t*	−2.40998	0.008	16	850
	Breitung t-stat	−0.03801	0.4848	16	834

Continued

Ho: Unit root (individual unit root)				
Im, Pesaran and Shin W-stat	−1.79969	0.036	16	850
ADF—Fisher Chi-square	43.0057	0.0926	16	850
PP—Fisher Chi-square	36.9657	0.2503	16	864

Table A.6.3. Stationary tests.

Variable	Method	Statistic	Prob**
LPTF	Hadri Z-stat	9.29993	0
	Heteroscedastic Consistent Z-stat	8.93155	0
LG	Hadri Z-stat	9.66802	0
	Heteroscedastic Consistent Z-stat	8.10874	0
LIG	Hadri Z-stat	9.1742	0
	Heteroscedastic Consistent Z-stat	8.10498	0
LM	Hadri Z-stat	11.4816	0
	Heteroscedastic Consistent Z-stat	9.77246	0
LGPIB	Hadri Z-stat	7.87163	0
	Heteroscedastic Consistent Z-stat	7.50091	0
LIGPIB	Hadri Z-stat	7.87163	0
	Heteroscedastic Consistent Z-stat	7.50091	0
LMPIB	Hadri Z-stat	11.5021	0
	Heteroscedastic Consistent Z-stat	10.4336	0

Note: these tests are available in Eviews and R.

Table A.6.4. PANIC tests 2010.

Variable	Model with constant and deterministc trend			
	Pooled	Pool.value	Model.C	Model.C
LPTF	Pa	0.2906267	ta	−1.362829
	Pb	0.3040682	tb	−1.403293
		PMSB	rho1	Pool.ADF
		0.3562268	0.9856549	−0.3700467
LGPIB	Pooled	Pool.value	C	Model.C
	Pa	0.2534956	ta	−1.352104
	Pb	0.2632605	tb	−1.489702
		PMSB	rho1	Pool.ADF
		0.3171416	0.9868038	−0.1941862
LIGPIB	pool_test	P mp_test	0	Model.C
	Pa	−1.364742	ta	0.6171061

Continued

	Pb	−1.201199	tb	0.5377475
		PMSB	rho1	Pool.ADF
		−0.9334927	1.005957	−0.9878564
LMPIB	Pooled	Pool.value	C	Model.C
	Pa	0.2534956	ta	−1.352104
	Pb	0.2632605	tb	−1.489702
		PMSB	rho1	Pool.ADF
		0.3171416	0.9868038	−0.1941862
LG	pool_test	P	mp_test	Model.C
	Pa	1.265976	ta	0.1746728
	Pb	1.566456	tb	0.2032701
		PMSB	rho1	Pool.ADF
		1.944328	1.002024	0.08065619
LIG	pool_test	P	mp_test	Model.C
	Pa	−0.8847976	ta	0.9690096
	Pb	−0.8095976	tb	0.9642431
		PMSB	rho1	Pool.ADF
		−0.6830585	1.009062	0.01987549
LM	pool_test	P	mp_test	Model.C
	Pa	−0.8846697	ta	0.9690139
	Pb	−0.8094908	tb	0.9642517
		PMSB	rho1	Pool.ADF
		−0.6829646	1.009062	0.01987549

Note: these tests were carried out with PANICr module.